RADIO FREQUENCY IDENTIFICATION (RFID) AT SMG MANUFACTURING, INC. *

by

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A Research Paper
Submitted in Partial Fulfillment of the
Requirements for the
Master of Science Degree
in

Management Technology

Approved: 3 Semester Credits

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May, 2004

* The name has been changed at the request of the company

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ABSTRACT

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Radio Frequency Identification (RFID) at SMG Manufacturing, Inc.

(Title)

Management Technology Jim Keyes May 2004 83 Pages

(Graduate Program) (Research Advisor) (Month/Year) (# of Pages)

American Psychological Association, 5th edition

(Name of Style Manual Used in this Study)

RFID is a generic term for technologies that use radio waves to automatically identify individual items. There are several methods of identifying objects using RFID, but the most common is to store a serial number that identifies a product, and perhaps other information, on a microchip that is attached to an antenna, the chip and the antenna together are called an RFID transponder or a RFID tag. The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves returned from the RFID tag into a form that can then be passed on to computers that can make use of it (Auto-ID Center 2001). RFID systems can be used just about anywhere, from clothing tags to missiles to pet tags to food -- anywhere that a unique identification system is needed. The tag can carry information as simple as a pet owners name and

address or the cleaning instruction on a sweater to as complex as instructions on how to assemble a car (Webopedia).

The focal point of this qualitative research is to examine how RFID will impact SMG Manufacturing, a division of a multinational company, focusing on the implementation of RFID, exploring how this technology can benefit SMG Manufacturing within their supply chain and developing an understanding of the Wal-Mart initiative, the Wal-Mart initiative has the top 100 suppliers using RFID tags by 2005 and all other vendors using RFID tags by 2006. Although, very few companies are in full production with RFID between consumer goods manufacturers, retailers and grocery chains, there is a major thrust to move this technology to the forefront.

Based on the review and inquiry of the data in this research study, five separate conclusions can be made. First, the Wal-Mart proposal will affect SMG Manufacturing in 2005 and concluding in mid to late 2006. Second, SMG Manufacturing must develop an implementation plan, which eliminates inefficiencies and expenses. Third, determining the best cost to performance balance will be part of the focus of the RFID team. Fourth, top management must be involved in the RFID deployment. Fifth, developing other RFID applications such as asset visibility, internal inventory control, labor reduction and maintenance parts tracking can help SMG Manufacturing realize benefits internally.

In general, SMG Manufacturing is on the correct path in terms of accepting RFID as a technology. SMG Manufacturing still needs to make sure they develop a business plan, which includes RFID as a strategic approach to developing a solution for both the Wal-Mart initiative and within SMG Manufacturing.

ACKNOWLEDGMENTS

The author wishes to express gratitude and indebtedness to those that have helped in directing, guiding, reviewing and planning this research project. A special thank you to my wife Jean for all the support and encouragement you have given, without it this project and Masters Degree never would have happened. Thank you to Ryan and Jenny for your encouragement; you don't realize how much you have helped. Thanks also to my Research advisor Jim Keyes for all his help and advisement; it was extremely beneficial to me in completing this research project. Thank you to the people at SMG Manufacturing, Inc., above all the Vice President and General Manager, Director of Logistics and Director of Product Development for all their support and assistance, you have provided the necessary help in making this all possible. Thank you also to all the professors at Stout that have instructed and guided me throughout my Masters, without your guidance and direction I would have never been able to attain the success I have accomplished.

TABLE OF CONTENTS

CHAPTER V: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

FIGURE

.

CHAPTER I: INTRODUCTION

Introduction

Radio Frequency Identification (RFID) also known as Automatic Identification (Auto-ID) is becoming a technology that more Consumer Package Goods (CPG) organizations need to be aware of, because of the initiative from Wal-Mart, the Wal-Mart initiative has the top 100 suppliers using RFID tags by 2005 and all other vendors using RFID tags by 2006 (Wal-Mart Supplier Briefing 2004).

RFID systems are complex in nature, but they can improve the way a company can plan and understand their own product movement throughout the supply chain. The systems are being developed to assist manufacturers and retailers understand their manufactured goods from the time they leave the manufacturing site to the time they are received in a warehouse or store.

As corporations depend increasingly on information to help manage their business, they will look to technology to help them develop systems to create better ways to use the information. RFID will be one of these systems. It will let an organization see where the product is located within any part of the supply chain. By being aware of where your item is located, manufacturing companies will be able to improve inventory accuracy, lower transportation and warehouse costs, increase sales and reduce lead times, while retailers will improve stock shelf rates, lower inventory, generate additional sales and lower logistics costs (Chappell, Ginsburg, Schmidt, Smith, Tobolski 2002).

RFID systems have been around for many decades, dating back to the 1960's when systems such as the electronic article surveillance (EAS) equipment were

developed to counter theft (Landt 2001). The systems today have become much more advanced with the progress in areas such as the Internet and wireless technologies, bringing RFID systems into areas that would not have been possible in earlier years.

There are three basic components to the RFID system that CPG organizations are working with (AIM, Inc.):

1. The antenna
2. The tag
3. The reader

Most CPG companies working with retailers and grocers will find the RFID system works like this; a tag is attached to a pallet, case or item. The tag itself contains a radio antenna and a unique identifier known as the Electronic Product Code (EPC). The infrastructure of the RFID system is based upon is the EPC. The EPC is a unique identifier for any physical object. When the tag passes within the range of a reader's electromagnetic zone, the reader detects the radio signal, which decodes the data on the tag and passes this data to a host computer. This occurrence takes place each time the tag passes within range of a reader. Readers need to read tags in the area of four feet away, but the read range will depend on the power and frequency the application uses. The RFID concept is explained in more detail in chapter two.

Auto-ID changes the paradigm; in that data capture is automatic, real time and almost free once the infrastructure is in place (Chappell, Ginsburg, Schmidt, Smith, Tobolski 2002). Unlike bar codes where the code has to be visible to a reader, the RFID system can read tags from a greater distance and they do not require the tag to be in the line of sight.

SMG Manufacturing, Inc. is one of the CPG organizations that desire to find out more about RFID systems and how to implement them to best fit into their current manufacturing structure. A RFID system is expensive, AMR Research estimates $13 to $23 million, to install and companies have to make certain when the installation of the project is completed, they have the optimal system they need to fulfill the requirements of each mandate from their customers (Red Prairie 2003). Companies are able to take further advantage of the RFID system by developing the system for future projects.

Statement of the problem

RFID technology has gained attention recently to replace or complement bar codes, but implementing this technology can be very time consuming and expensive. The objective of this study is to identify, explore and examine the factors that affect a RFID system for SMG Manufacturing. With the initiative from Wal-Mart, developing an implementation plan early will result in better decisions when it becomes time to install the different pieces of the RFID system. The ability to do research upfront before dealing with the Wal-Mart proposal gives the company time to sort out the direction it will need to undertake in order to develop the system for current considerations and into the future. Recommendations on how this should be accomplished will be discussed in a later chapter.

Purpose of the study

The purpose of this study is to identify RFID, determine how RFID will affect SMG Manufacturing and develop a sound implementation strategy. Wal-Mart works with

manufacturing companies such as SMG Manufacturing to find cost reductions in the supply chain. RFID is another technology that they are using to gain an advantage in the supply chain over their competition. SMG Manufacturing has been working with Wal-Mart the better part of twenty years. Developing the knowledge of the RFID technology before it has to adopt the technology gives SMG Manufacturing an upper hand and helps them prepare for the RFID system when it needs to be implemented. SMG Manufacturing is in the second wave of vendors in the Wal-Mart proposal, so they gain an advantage by using information, strategies and courses of action other companies have developed and they need to transfer this knowledge to assist them in overcoming obstacles to a successful implementation.

Significance of the study

The significance of this study is to assist SMG Manufacturing in developing an implementation plan, gain knowledge about the system, develop a better understanding of the benefits and costs, and determine how this technology affects SMG Manufacturing. The implementation plan must first develop the RFID system to address the Wal-Mart initiative. After the initial Wal-Mart installation SMG Manufacturing must also expand the system for other customers. The plan in addition needs to build the technology within SMG Manufacturing and take advantage of the other benefits offered by using the RFID, which are explained in further detail throughout the research paper. The plan needs to be developed so it can be useful to other SMG Manufacturing divisions located throughout the world, by using the lessons gained to find out what it takes to make the RFID system reliable. As RFID systems become more prevalent and standards are developed by world

organizations, this technology will become more mainstreamed and SMG Manufacturing will have laid out the groundwork to transfer the knowledge it has attained to other divisions in the company.

Research objectives

The research objectives of this study are to find the RFID features that affect SMG Manufacturing such as, identifying a RFID implementation and defining the Wal-Mart proposal to use RFID as a strategic business technology. Since Wal-Mart announced their intention to use RFID technology, RFID implementations are increasing dramatically. This technology is gaining more attention and referencing RFID Anthony Bigornia (2004) an IBM business consultant declared the RFID technology is the next revolution in the supply chain. SMG Manufacturing has to position itself to take advantage of the technology by using information other companies have prepared on testing and developing systems for Wal-Mart and other RFID proposals. The EPCglobal network, which has transitioned to EPCglobal from the Auto-ID Center, and the Internet have been the main focal points used by the researcher to develop and find opportunities for SMG Manufacturing in acquiring the data needed to implement the RFID system.

Assumptions of the study

The researcher assumes the Wal-Mart initiative will take place during the years 2005 through 2006 for most companies and SMG Manufacturing will be included in this group of manufacturers adopting and testing RFID beginning and ending during the same

years. Other customers of SMG Manufacturing are planning RFID systems, but the Wal-Mart proposal is the first priority. The researcher also assumes the RFID technology will not significantly change in the near future. The researcher as well assumes SMG Manufacturing will use RFID at the case and pallet levels in the first RFID implementation phase with Wal-Mart and not develop item level tagging for some time to come.

Definition of terms

The following definitions and terms were used in writing this research paper (AIM).

Active tags: Tags, which use batteries as a partial or complete source of power.

Antenna: The conductive elements, which radiate, and/or receive energy in the radio frequency spectrum, to and from the tag.

EPC: The Electronic Product Code (EPC) is a new product numbering standard. The 96-bit EPC code links to an online database, providing a secure way of sharing product-specific information along the supply chain.

Frequency: the number of times a signal executes a complete excursion through its maximum and minimum values and returns to the same value (e.g. cycles).

Inductive Coupling: Systems, which use the inducing of a current in a coil as a means of transferring data or power.

Open Systems: Application in which reader/writers do not have access to a common database.

Passive Tags: Contain no internal power source. They are externally powered and typically derive their power from the carrier signal radiated from the scanner.

RFID: Systems that read or write data to Radio Frequency (RF) tags present in the frequency field projected from the RF reading/writing equipment. The system incorporates the use of electromagnetic or electrostatic coupling in the RF portion of the spectrum to communicate to and from a tag.

Range: The distance at which successful reading and/or writing can be accomplished.

Reader: The device containing the digital electronics that extracts information. The digital electronics perform the actual reading function.

Scanner: The antenna, transmitter and receiver electronics integrated into a single enclosure.

Tag: The information storage mechanism attached to the object. This is also referred to as the transponder, electronic label or code plate.

Limitations of the study

Limitations are factors, usually beyond the researcher's control, that may affect the results of the study or how the results are interpreted (Baron, 2001). Limitations to this research projects are as follows:

1. The research study is for SMG Manufacturing. The researcher limited this study to RFID issues affecting only SMG Manufacturing.
2. The research study follows the Wal-Mart RFID requirements. Wal-Mart specifies their requirements in a twenty-five-page document that SMG manufacturing must follow.
3. The research study is developed for the pallet and case levels. Since the current proposal from Wal-Mart indicates RFID tagging at the case and pallet level, this research is also developed at that level.
4. The research study does not explain how to implement RFID. The researcher only explains the implementation method; the research does not test the actual implementation method.
5. The research study does not test equipment, tags or readers. Due to the expense of the testing process the researcher has not tested all equipment, tags and readers.

Methodology

The methodology the researcher used is the historical method, because no measuring instruments were utilized and previously produced documents determined and formulated the conclusions and recommendations (Ledbetter 2001). Etten states from the

Encyclopedia Britannica (2002), the historical method involves systematically and objectively locating, properly selecting, and critically examining source materials; analyzing, synthesizing, and evaluating facts from these source materials to draw conclusions about past events and issues; and drafting them into a narrative that will stand the test of critical review. The researcher used the most current data available in the research by taking every effort to making certain that the sources were reliable. Properly deciding and analyzing source materials is essential to any historical research. Because of the historical nature of this research project, SMG Manufacturing needs to update the research according to any changes that have occurred as more implementations are completed by companies developing RFID systems for Wal-Mart or other retailers.

CHAPTER II: LITERATURE REVIEW

Introduction

In this chapter, literature review, the researcher will discuss how technological changes have influenced the supply chain. Speed and delivering products to the consumer on time have become a major push to manufacturers, grocers and retailers. Having products on the shelf when a consumer is there to purchase it, will increase sales, decrease out of stocks and lower inventories, which has been the driving force of Supply Chain Management (SCM). Radio Frequency Identification (RFID), tags, the Internet, bar codes, databases and wireless technologies will be discussed as to their impact on the supply chain and getting improved results from a companies supply chain management system.

RFID Introduction

RFID or Auto-ID is a term given to a technology, which captures information about an item and subsequently downloads this information internally or via the Internet to a host computer database without any manual or human intervention. According to Das (2004) RFID is a term used for any device that can be sensed at a distance by radio frequencies or thereabout, with few problems from obstructions or mis-orientation.

RFID systems consist of a tag attached to a container, package, vehicle or mechanism utilizing a bar code or tag. These tags contain an antenna, which transmits an Electronic Product Code (EPC) to a reader. The reader sends the EPC across the Internet through an Internet Protocol (IP) address or internally to a hosting computer. The EPC itself consists of four fields: the version number, manufacturer number, product number

and a unique serial number for each individual tag (Sarma, 2001). The hosting computer matches the EPC information to any and all software that needs to know the location of the tag or item, thus completing the supply chain cycle. RFID systems create improved visibility for a company along the supply chain. This visibility enhances how a company can set inventory levels at each stage of a products journey to the end consumer, creating a system, which will decrease costs and improve efficiencies, for the manufacturer, retailer and consumer.

Basic Supply Chain

The basic supply chain emerges from the time a raw material flows from the raw material supplier to the final consumer of the product. Many components are included in a supply chain such as; supply and demand, raw material sourcing, production, assembly, warehousing, inventory, order management, distribution and delivery. Supply Chain Management (SCM) has come to the forefront as a way to control and manage the components inside the supply chain. According to Lummus and Vokurka (1999) the concept of managing the supply chain implies managing across typical organizational boundaries. These boundaries include both interdepartmental boundary lines within a company and boundaries between companies. Understanding a company's supply chain is always a major undertaking, but when this is achieved it can have a powerful impact on short and long term goals.

Supply chain management has three main objectives (Pagel 1999):

1. Get the right product to the right place at the least cost.
2. Keep inventory as low as possible and still offer superior customer service.

3. Reduce cycle times. Supply chain management can involve operations that deal with the way customer orders are processed through the system and ultimately filled, as well as how raw materials are acquired and delivered for the manufacturing process.

Companies need to understand the supply chain in order for RFID to function properly. The research for this project is limited to the RFID viewpoint and SMG Manufacturing understands and has processes in place to enhance the three objectives Pagel mentions in his article. RFID with enhance the three objectives by giving a company the visibility to know when and where the product produced is located throughout the supply chain.

Technological Advances

In the supply chain world, technological advances have developed software, hardware and processes, which have brought about changes creating decreased costs and improved efficiencies for companies. Developments such as Vendor Managed Inventory (VMI), strategic sourcing, and Collaborative Planning, Forecasting and Replenishment (CPFR) have given companies an awareness of how technology will change the way they see the supply chain now and in the future. The researcher explores how technological changes in databases, the Internet and wireless technologies have given the RFID movement further innovations in developing tools, which helped bring this technology to the supply chain forefront.

Databases

One of the most significant aspects of the computer revolution has been the concept of a database: the storage of information in such a way as to enhance our use of it (Toonen 1998). The first databases developed were identified as Databases Management Systems (DBMS), these databases advanced quickly during the 1970's (Toonen, 1998). Because of the time commitment to develop and maintain this kind of database a more robust database known as a Relational Database Management System (RDBMS) was created (Brown, 2002). RDBMS is extremely efficient information technology advancement and is the principal asset to an organization. A relational database is a series of tables with an assortment of data items fit into predefined groupings. They are relatively easy to set up, access, and enlarge. With the amount of data flowing between the Internet and databases due to RFID, pressure has mounted on hardware and software vendors to create solutions to the process without causing any more difficulties. Beyron-Davies (2000) stated the future of databases will be inextricably linked to the development of the Internet. This is a major factor of the work being done implementing a RFID system.

Internet

In 1973 the U. S. Defense Advanced Research Projects Agency (DARPA) initiated a research program to investigate techniques and technologies for interlinking packet networks of various kinds. This was called the Internetting project and the system of networks, which emerged from the research, was known as the "Internet" (Internet Society 2001). The Internet is a collection of networks connected together in different ways to form a single entity. Computers connect to this entity through a series of Internet

Service Providers (ISP) or Point of Presence (POP) networks. Because there is no overall-controlling network, many high level networks connect to each other through Network Access Points (NAP), dedicated backbones or routers. Networks talk to each other through these NAPs, backbones and routers. Routers are basically computers, which determine where to send information. An Internet Protocol (IP) address communicates through routers by using computer languages. IP addresses are unique identifying numbers to tell the computer where to look for the number and where to find the address. Communication within the Internet is done through a domain name, which contains the Uniform Resource Locator (URL). A Domain Name Server (DNS) begins a search for an IP address when a URL in typed in to a requesting computer (Tyson). The Internet is an integral part of the backbone system for RFID. RFID will utilize the Internet by transmitting through an IP address, EPC information to a hosting computer.

Wireless Technology

Wireless communication is the contact between objects without the interaction of wires or cables. By using wireless technologies an organization will gain economic benefits such as wire cost, speed of deployment and the simplicity of reconfiguration and expansion. As with any technology, wireless also encounters problems that need to be addressed when designing and implementing a wireless system. Areas of concern would include dependability, skilled labor, additional control points and ease of claimed expansion. These areas need to be dealt with to make sure the system put into operation is as reliable as a wired system. Although speed is often the focus for data networks, the primary objectives for industrial control and sensing networks are reliability, adaptability

and scalability. Reliability of a wireless network is essential, without reliability, system failures become extremely devastating. In a wireless network the surroundings should never be made to fit to the wireless system, the wireless system should always fit to the surroundings. Adding new devices to a wireless system should be reasonably easy, because with any network, the network should be developed with expansion in mind for the future (Poor 2004). Again wireless technology is a major function in any RFID system. Being able to communicate between tags and readers is the main reason RFID has become a major push in the supply chain and using wireless technology creates a system to accomplish it. Developing a system whether wireless or not involves time and money.

History and Evolution of the Bar Code

Retailers and manufacturers have always wanted to find ways to use technology to help them get visibility to information about products both inside and outside their four walls. In 1932 Wallace Flint tried to automate a checkout system, but this system turned out to be too cumbersome to install (Hagey 1998). Other systems were also tried through the years1940 to 1960 such as the bull's-eye code, numeral codes and a variety of bar code formats, but because of cost, equipment and technology, these systems were also abandoned. In 1973 IBM along with a new standards board, created by a committee of grocery industry management, developed a standard symbol known as the Uniform Product Code (UPC) (Hagey 1998). The UPC is also known as the bar code, because of the unique way the symbol is made- up of a series of bars and spaces. As indicated by

Brian (1998), the bar code is divided into six elements starting from left extending to the right:

1. The first part of a UPC symbol is the left guard pattern. This consists of two thin vertical lines a bit taller than the other bars. The guard pattern doesn't contribute to the actual code, but is simply an indicator to identify the start of a UPC symbol.
2. The second part of a UPC symbol is the number system digit, which indicates what type of product the symbol is identifying.
3. The third part of a UPC symbol is the manufacturing code. This consists of five numbers, their corresponding bars, and identifies the product manufacturer.
4. The fourth part of a UPC symbol is the center guard pattern, which consists of two thin vertical lines a bit taller than the other bars. The center guard pattern divides the symbol in half.
5. The fifth part of a symbol is the product code. This consists of five numbers, their corresponding bars, and identifies the product.
6. The sixth part of a UPC symbol is the check digit, whose value is based on weighting of the other digits in the code.

The UPC symbol has been around for over thirty years and has been remarkably reliable and consistent. The symbol's use will extend far into the future, due to the heavy investment manufacturers, grocery and retailers have put into the UPC symbol. RFID tags and bar codes will work side by side with each other in the near future or until the RFID information structure develops into an economically viable option for all manufacturers from large to small.

Figure 1 illustrates an actual bar code from a bottle of diet coke (Brian, 1998).

Figure 1: Bar Code

RFID Systems

The RFID system will automate the supply chain and unlock unprecedented value throughout the supply chain stream. It will allow computers to see physical objects and assist manufacturers and retailers to track and trace their items automatically. RFID will be the next piece of the supply chain that will revolutionize the

The RFID system will automate the supply way a company will conduct business. The system consists of three components, the antenna, the reader and the transponder. The system operates as follows (Kleinberger, 2003):

1. Every item contains a tiny microchip embedded in it that has a radio antenna and a unique identifier called an EPC. Pallets and cases will also carry their own unique tag.
2. As the pallet leaves the manufacturer a RFID reader positioned in the loading dock will send an electronic radio wave to the tag and in turn energize the tag.

3. The individual EPCs, each item inside the case, broadcast their information to the readers. This is done in rapid succession until all the tags have been read. The reader then sends the EPCs to a computer running the software Savant. The EPC is then sent over the Internet or internally to an Object Name Service (ONS) database, which then creates an address. The ONS matches the EPC up to another server called the Physical Markup Language (PML) server that contains all the pertinent information about the product. The PML server stores all the data about the manufacturers' products. The server identifies the location of the reader sending in the query and at what location the product was produced. This will help in determining where a defective product originated when a recall takes place.
4. The truck leaves the producing facility, arrives at the customers' warehouse and is unloaded. There is no need to open packages or containers to examine the contents because the RFID readers read the tags, the software provides a packing list and the pallet is routed to the appropriate truck for shipment to the store, all by reading the tag when it enters the warehouse. This assists the warehouse to become more efficient by helping handle the products coming through the doors. The warehouse becomes a true cross dock, moving product from the supplier's truck through the distribution center and onto a store-bound vehicle without putting them into pick or reserve slots, facility (Rada, 2001).
5. When the shipment leaves the warehouse, the customer tracks the shipment with the Savant software connection. When the shipment arrives at the store, the retail systems will be updated to include the items that arrived. Readers read each tag

that comes through the stores receiving door. The store has an accurate inventory and items can be located instantaneously. Each store also has the ability to lower inventory in the back room for shelf stocking, because of the accuracy of the inventory.

6. Readers are placed on the shelves in the store, and automatically order additional products from the back room, warehouse or manufacturer based upon consumption. These “smart shelves” will identify what products are being pulled off the shelf and if they have been scanned through the store scanner for purchase. This will decrease the amount of safety stock needed in the supply chain in order to keep the shelves in stock and will also deter shrinkage from theft.

Due to the fact that item level RFID tagging is still in the very early development stages, this researcher has examined RFID systems at the pallet and case level. Item level tagging will increase the costs in all aspects of the supply chain and benefits derived from these systems still need to be determined.

Appendix A displays how all the pieces of the RFID concept fit together, but currently the only feasible RFID concepts in production are to the back rooms of the store on pallets and cases. The concept of getting a tag to a consumers home is still along ways off and there are to many privacy issues and costs to doing this model to make it realistic.

Auto-ID Center

The Auto-ID center is a non-profit organization formed to develop a RFID system using the Internet to identify goods anywhere in the world (RFID Journal 2004). Founded in 1999, it created a unique partnership between business and academia to put together

the necessary elements to create a successful global network based on a low cost RFID system. Working with leading companies such as Wal-Mart, Coca-Cola, Gillette, Johnson & Johnson, Pfizer, Proctor & Gamble, Unilever, UPS and IBM and with three of the leading research universities, the Massachusetts Institute of Technology, the University of Cambridge in England and the University of Adelaide in Australia, the center has been able to create a powerful and intellectual force to undertake this problem and find a viable solution. The center launched the first large-scale field test of the system at a Sam's Club in Tulsa, Oklahoma in October 2001. The test has generated a large amount of valuable information for its sponsors and they have been able to gain insights into how the system will work and what needs to be done to fine-tune it to allow for better product movement through the supply chain at the least cost. The Auto-ID center has been diligently working with hardware vendors to help in bringing down the cost of the readers and tags. The goal is to have a tag that costs less than 5¢ and a reader for less than $100 by 2005. The center also started working with international organizations to create standards, which will be used throughout the world. They have joined forces with the Uniform Code Council (UCC) and the European Article Numbering (EAN) international council to assist in administering this standard. The Auto-ID center has since disbanded, but has transitioned to EPCglobal. The technology and testing that was done at the center has shaped the way the RFID system will perform for now and into the foreseeable future.

Electronic Product Code (EPC)

The EPC is a labeling scheme that is embedded into each RFID tag by a RFID printer. There is little difference from the current bar code in that the EPC tracks and identifies items, but unlike the bar code the EPC does not have to be in the line of sight of the reader scanning the EPC tag. The EPC will follow in a hierarchical design from shipment, to pallet, to case and lastly to the item level. Each of the different levels will have their own separate and unique EPC number. The EPC consists of four fields, the first field being the header or version number, the second field is the manufacturer number or EPC manager, the third field is the product number or Object class and the fourth field is the unique serial number (Lowry, 2004). Depending on the length of the version number the EPC will be either 64 or 96 bits long. SMG Manufacturing will use the 96-bit version. Glancing at the 96-bit type, the header or version number identifies the EPC protocol being used and is 8 bits in length. The manufacturer or EPC manager number identifies the manufacturer, which manages this particular set of EPC numbers and is 28 bits in length. The product number or object class identifies the type or class of the item, which the tag is attached to; this could be a pallet, case or item and is 24 bits in length. The last number is the serial number and identifies the globally unique identifier. The serial number is 24 bits in length. Figure 2 illustrates the 96-bit EPC from the Auto-ID Center (Ashton, Sarma 2003).

When a reader reads each EPC, the reader sends the EPC to a computer running software called Savant.

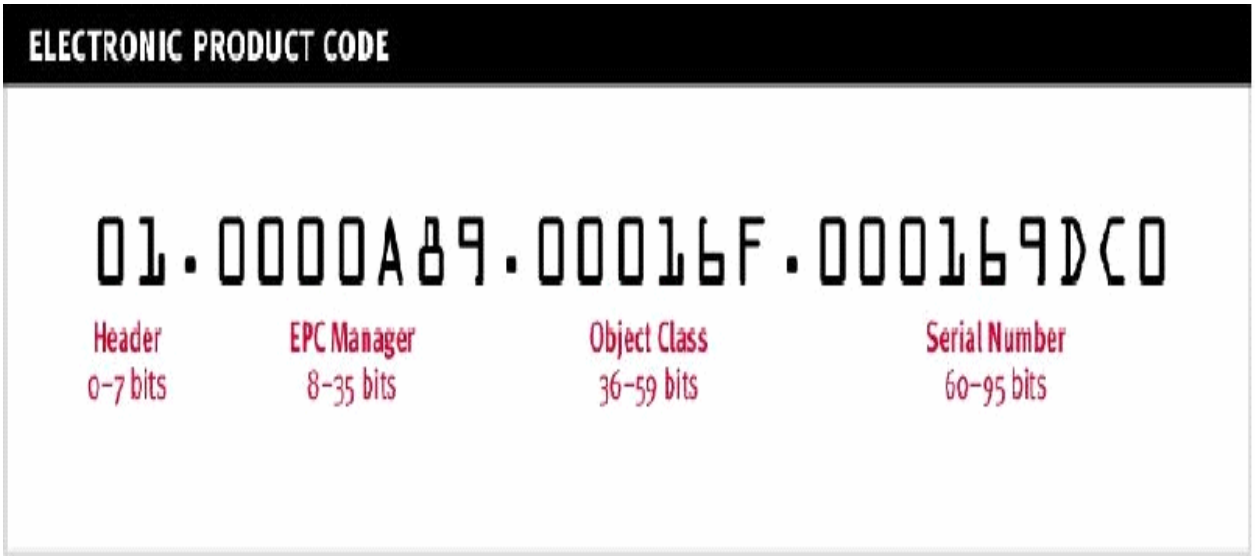

Figure 2: Electronic Product Code

Savant

The Savant in the EPC infrastructure is positioned at the very beginning of the process when a reader has read a tag. As its name implies the Savant element in the EPC infrastructure performs a particular function and does it extremely well. With the volume of data likely to be seen in commercial settings, a RFID reader may detect a hundred EPCs per second, the data challenges border on those found in processing telemetry. Thus, there has to be a filtering layer between the tag readers and the enterprise network (Meloan, 2003). Savant is basically a data router that performs operations such as data capturing, data monitoring, and data transmissions. There are three modules to the Savant. The first is the Event Management System (EMS) and it has seven requirements (Oat Systems & MIT Auto-ID Center 2002).

1. The EMS should be a high performance system.
2. It needs to communicate with different protocols.

3. Event filters need to be supported.
4. Each processing unit should operate as independent threads without blocking each other.
5. It needs to be able to buffer event streams between units.
6. The EMS has to be able to instantiate the processing units based on any configuration.
7. It should allow remote machines to register and deregister events dynamically.

The second module is termed real-time in-memory data structure (RIED). The RIED maintains a snapshot of the database at different times. This module needs to be a simple, high performance, multi-versioned in-memory database. The database has to be capable of maintaining multiple snapshots. The third module is the Task Management System (TMS). This module will provide an external interface to schedule tasks, use a virtual machine in which uniform libraries are loaded on-demand, and create persistent information about tasks. The module will also have the capability to restart tasks in the event of a program or task crash. The module will use small memory footprints that are built on an open, independent platform standard (Oat Systems & MIT Auto-ID Center 2002). The Savant transmits the EPC over the Internet or internally to the Object Naming Service (ONS).

Object Naming Service (ONS)

The EPC is mapped to an Internet Protocol (IP) address that stores the tag information through a service called Object Name Service (ONS), which is similar to the Domain Name System (DNS) that points a computer to a particular site on the World

Wide Web (WWW). According to the Auto-Id Center (Oat Systems & MIT, 2002), the mapping information in the ONS framework should be maintained in a hierarchical fashion involving the EPC namespace authority, the manufacturers and product-specific divisions of the manufacturers. Thus we have these five requirements (Oat Systems & MIT Auto-ID Center 2002):

1. The ONS framework should allow hierarchical management of the mapping information.
2. The ONS framework should allow the caching of mapping information held in the ONS servers.
3. The ONS framework should allow the same mapping information to be stored in redundant ONS servers.
4. The ONS framework should allow EPCs to be mapped to redundant PML servers.
5. The ONS framework should allow the addition of new versions of EPCs with no changes to its software or hardware components.

The ONS points the software to look in the corporate database to find the information stored about the product. The ONS is an open global network for tracking goods and requires special network architecture. The system has to handle many requests, so companies will need to maintain ONS servers locally for quicker retrieval of information. This will also enable the company to pull information from its own network, rather than having to get it off the Web every time a shipment arrives at its destination (Oat Systems & MIT Auto-ID Center 2002). The ONS stores the EPC in a PML (Physical Markup Language) format.

Physical Markup Language (PML)

The Physical Markup Language (PML) is based on the eXtensible Markup Language (XML) standard. XML tells the computer what kind of information it is viewing (e.g. an address or telephone number). The PML will go even further building layers of increasingly specific data in order to describe a physical objects (case, pallet, bag, razor pack, etc.) design, status and condition. The PML should do the following:

1. Translate and contain static data such as dosage, shipping expiration, advertising and recycling information.
2. Provide instructions for machines that process or alter a product, such as: microwaves, laundry appliances, machine tools and industrial equipment.
3. Communicate dynamic data: information that changes as a product ages or is consumed, such as: volume, temperature, moisture, location and pressure. (Smart Labels Analyst 2003).

PML describes all physical objects, processes and environments that cover all industries. In order to provide information PML grants access to a number of constructs and data types. These include a data element, which captures a ‘snapshot’ of the physical environment. A node element, communicates the chain of command in a physical system structure. The trace element records not only where an object is, but also where the object has been. The entity element contains information necessary to assign ownership and responsibility for physical objects. The final three sections location, date and measure specify the location of an object, time of observation and data measurements, such as weight or temperature (Brock, Milne, Kang, Lewis, 2001). Manufacturers, retailers and

grocers can use the information stored in the PML network to retrieve updated data for inventory purposes, expiration dates, shelf life, transportation issues and other aspects of the business that need real time facts. Figure 3 from the Auto-ID Center (Ashton, Sarma 2003) demonstrates how the EPC network interacts with each other.

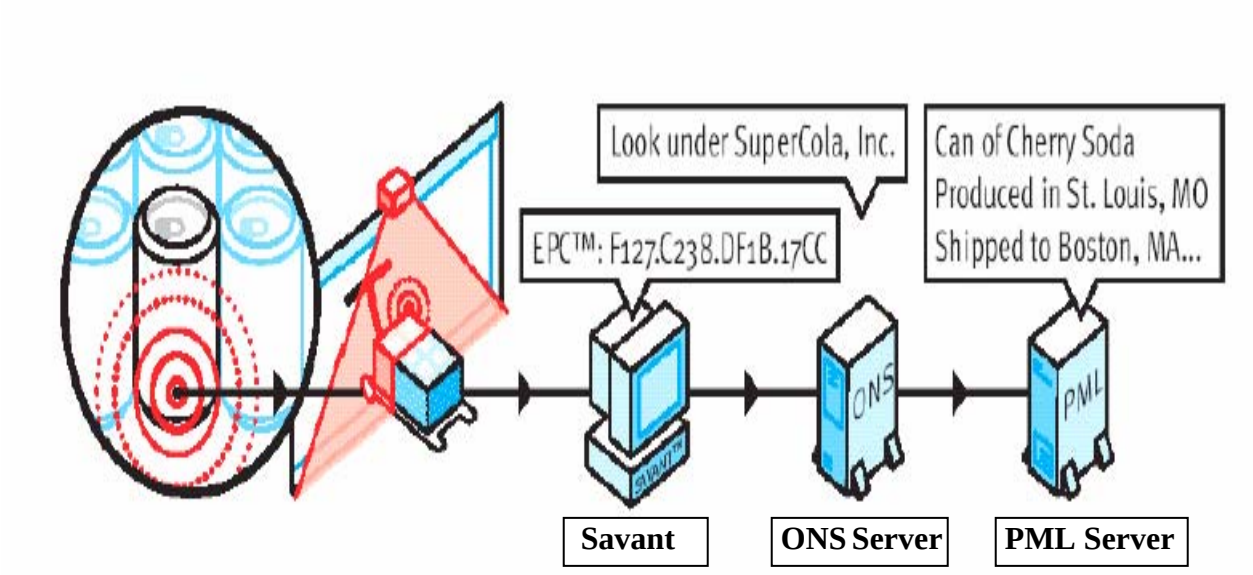

Figure 3: Savant, ONS, PML Interaction

Tags and Readers

RFID tags fundamentally fall into two categories, active or passive. Active tags have a battery, which operates a microchip and broadcasts a signal to a reader, much in the same way a cell phone works. The active tags use the battery to control the internal circuitry, giving the tags a longer read range, quicker read times and the logic to be able to make use of its internal intelligence. The disadvantages of active tags are cost; the tags cost one dollar or more (Auto-ID Center), making them more expensive than passive tags. Active tags also require more maintenance due to keeping the battery recharged. In view of the fact active tags have these drawbacks; the tags are mainly functional for items

needing to be scanned at long ranges (100 feet or more) such as railroad cars in a rail yard or passenger cars in an inventory lot waiting for shipment (Auto-ID Center, 2001).

Passive tags are the most commonly used tag which Consumer Package Goods (CPG) companies such as SMG Manufacturing would use in their RFID system. The tags do not require a battery; instead the tags draw power from the reader. The reader transmits an electronic wave, which makes a current in the tags antenna respond and send the information contained on the tag back to the reader. Passive tags in general are read-only and preprogrammed with a unique set of data attached that cannot be modified. Read ranges are shorter (10 feet or less) and read times are longer. The longer read times are caused when broadcast energy from the reader reaches the antenna of a passive tag; it is used to charge a capacitor. When enough energy has been stored on the capacitor, the chip starts operating, unlike the active tag which does not need to wait for energy to be transmitted from the reader (Lowry Computer Products 2004). Most manufacturers, retailer and grocers use warehouses and stores to stock inventory. The warehouses and stores are in a more confined area and use dock doors to move product in and out, so the passive tag works more efficiently with the shorter read ranges when a reader is placed at the dock door.

RFID tags are limited in various ways. Lowry Computer Products (2004) explains the problems this way:

1. Read Accuracy.

   The accuracy of a read from a tag is related to the amount of time spent by the reader with the individual tag. As the quantity of tags to be used increases and the speed at which they pass through the field

of a reader increases, the amount of time available for any particular tag decreases. Ultimately, this dynamic limits the number of tags that can be presented to a reader at a time.

2. Interference from surrounding materials.

   In order to be universally useful, tags must be able to be affixed to almost any material and surrounded by almost any material. At the present time, only a relatively modest sampling of materials has been characterized for their influence on RFID communication. In particular, stretch wrap is a widely used packing material, especially for goods on pallets. It is also known to generate large static electric charges as it is applied. How reliably RFID transmission will operate in the presence of large static electric fields is not fully understood. Likewise, liquids and metals are known to alter the characteristics of the RFID radio transmissions. Appropriate methods for tagging materials that contain large amounts of either (or both) are not currently agreed on.

3. Price.

   The current price point for a complete tag is under a great deal of pressure. Prices vary widely depending on the volume an application uses. It is not yet known how or when an economically attractive price will be achieved. The current price of a tag is 20¢ for an order

of 1 million or more tags. This is still not at the economical price of the 5¢ tag, but as Alien states, users need to see there is a roadmap toward the 5¢ tag (Collins 2004).

Whether using a passive or actives tag is generally determined by the read ranges and the application needed. Figure 4 illustrates an example of a RFID tag (Meloan, 2003).

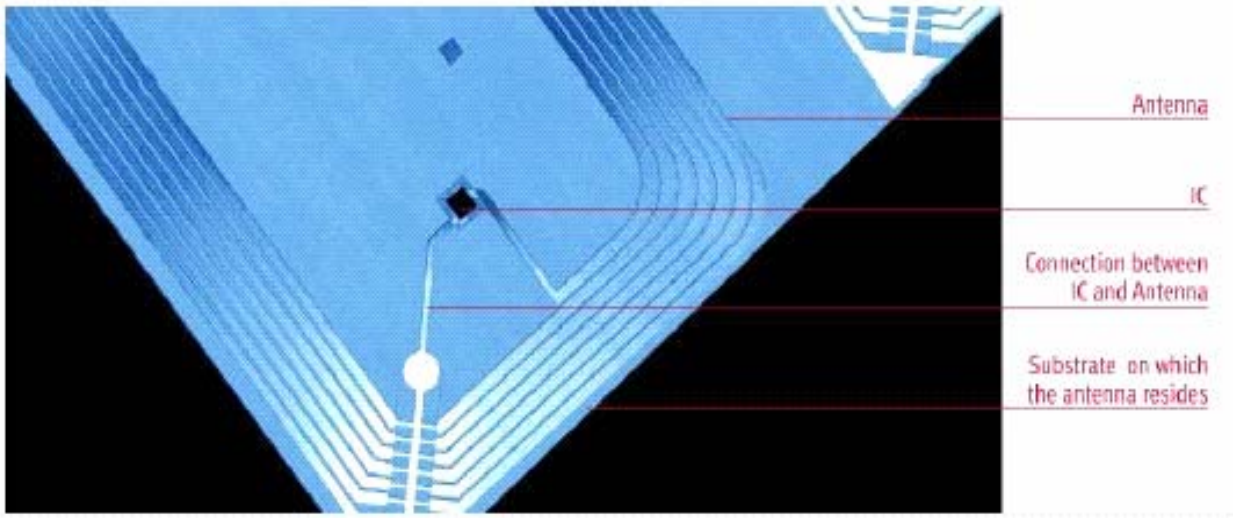

Figure 4: RFID Tag

RFID readers use different techniques to communicate with RFID tags. The most common method is inductive coupling, which uses a coiled antenna off the reader to create a magnetic field. This magnetic field communicates with the antenna of the tag. The tag draws its energy from the magnetic field and uses it to transmit back waves to the reader, which is turned into digital information. The readers need to be designed so they are agile enough to read chips of different frequencies. The readers also have to be cost

effective. Current models cost in the range of $1,000, but need to be more affordable in the $100 range (Auto-ID Center). They need to avoid what is called reader collision. Reader collision happens when one reader signal interferes or overlaps with another reader. To avoid this problem, a scheme called Time Division Multiple Access (TDMA) is used. This scheme instructs the readers to read at different times, which ensures that they do not interfere with each other. Using this scheme does create a different problem, where two readers in the same area overlap and read the tag twice. The system has to be developed to delete duplicate codes that have been read by the readers. The readers are not the only victims of collision problems; the tags also can develop the collision problem. Tag collision happens when more than one tag sends a signal back to the reader at the same time, thus confusing the reader. A standard has been created to solve this problem. When a reader detects an EPC it will ask the tag to respond only if it's first digits match the digits being communicated by the reader. If the EPC begins with 0 and more than one tag responds to the reader, then it will ask for a response from any EPC starting with 00 and will keep doing this until a single tag responds. This happens so quickly that a reader can read 50 tags in less than a second (Auto-ID Center, 2001). Typically a reader needs to be agile enough to read tags in the vicinity of four feet away, but the read range will depend on the power and frequency the application uses. A network of readers throughout the supply chain provides the ability to pinpoint where each individual tag is located.

Current uses of RFID

Companies are using RFID in creative ways. Johnson Controls of Livermore, CA produces state-of-the-art automotive seats for New Motors Manufacturers, Inc. (NUMMI), a production facility jointly operated by Toyota and General Motors. At its own modern plant, Johnson Controls manufactures a variety of car and truck seats for the NUMMI plant, which is located 20 miles away, in Fremont, CA (Huff 2003). Johnson Controls uses Just-In-Time (JIT) technology and any mistakes create numerous problems throughout the production line. To control the problems Johnson Control implemented a RFID system, which tracks a seat through the production process. In pre-RFID days, car seats went through the assembly line in matching groups, but now, they are able to mix and match at will on the same production line. As a seat reaches a station, the tag is read and if the tag indicates the seat needs modifications, the system will tell the conveyor to simply bypass the station. Libraries, such as the Rockefeller University Library use RFID tags affixed to books and materials to record what books are shelved. The tags also trigger sensor alarms, notifying librarians to material not properly checked out. A RFID tag can be read from just inches away, enabling the librarians to wave a wireless wand while walking through stacks to record what books are on the shelves. The handheld unit reads the tag and stores the tag data, which can be downloaded into the library's circulation system. Instead of weeks or months, collection inventory, the libraries supply of books, takes just hours (Mayfield, 2002). People that ski are noticing the changes RFID technology also has made. At the ski lift a skier used to get a paper ticket, which needed to be scanned, every time the skier went through to go up the ski lift, making a very labor-intensive process. RFID offers an ideal alternative by replacing paper tickets with contact-less smart cards or disk transponders (Finkenzeller 2003). Read ranges are

calculated so the transponder can remain in a jacket pocket and not in the skiers hand. The system works as a skier walks through a turnstile; two antennas opposite each other screen each skier by reading the transponder when the skier enters the read range of the antennas. Gillette Company started testing smart tags to track their razor products in January 2003. It has purchased a half a billion tags from Alein. They tested tags on pallets, cases and individual product packages. Paul Cox, a Gillette spokesman states, the retail industry lose billions each year by not having available product on the shelves, often available product is sitting in warehouses or stock rooms (Gatlin, 2003). Razors from Gillette are also a popular target for shoplifters and with the tags the product can be tracked from the shelf to when it leaves the store, alerting security that the product is leaving without being paid for. Another RFID example belongs to Ford Motor Company. Ford has developed a system they call their asset tracking system. Tracking down errant vehicles was costing Ford a great deal of time, sometimes requiring them to periodically shut down the plant. With help from WhereNet software they developed a wireless tracking system. Ford has a network of receiving antennas' covering both the plant's interior and vast yard areas where their assembled vehicles are stored prior to being shipped. Before the vehicle is brought into the yard an employee hangs a radio tag on the vehicle. The tag and the vehicle identification number (VIN) are scanned and the software then associates one with the other. Receiving antennas' pick up signals and determine the location of the tag by triangulating, divide into triangles, the origin of the signal. The tag is scanned again prior to shipment and informs the plant's quality control system. It is then determined if the vehicle needs any last minute adjustments. Once the vehicle is cleared to ship, the tag is removed and used again. Ford has estimated that it

saves $500,000 to $1 million annually per plant in warranty and labor cost reductions (Reese 2002).

Implementation Methods

Implementing a RFID system takes allot of time and effort. Manufacturing companies need to develop plans to help them understand all that is involved in bringing a RFID system to completion. Asking the right questions and getting correct answers will take a company along way to surviving the task of developing a under developed and untested technology such as RFID. Zebra (Zebra Technology Corporation 2004) developed a ten-step process for manufacturers, grocers and retailers to use in implementing an RFID project. The first step is to consider the impact on the organization. Efficiently capturing data is a main force of RFID, but using the data to improve business processes needs to be resolved. The corporation should focus on answering key questions; what business problems can be solved using this system, where can RFID give us the biggest bang for our buck now and in the future, what efficiencies and customer service improvements can be gained when the system is implemented. The second step is to summon your allies. Find out who exactly will benefit from the RFID project. Gain their confidence, educate them and make sure they are willing to put the effort needed to accomplish this goal. The third step is to assemble the troops. A major and critical action is to get upper management to buy in. Having upper management on-board quickly will ensure the project will run smoothly and be completed on time. The project has to be developed as a company-wide integration, because it will affect the entire business. The fourth step is to know the processes. A company has to understand its current business processes. Key to getting the full value of any RFID system is identifying how the business will change. If

the system is developed to take out inefficiencies in the current system, the system will be better received. The fifth step is to identify targets. Consider the impact the RFID system may have on inventory, assets and operations and develop it towards making improvements in these areas. Do not stop at these areas, once you have the installation complete look for other ways in which RFID can enhance the company processes. The sixth step is to envision the future. Developing the system to comply with one or two initiatives will only help the organization in the short term. The company plans should be developed for its current requirements and five, ten and twenty years into the future. The seventh step is to understand the technology. The planning process should include hardware, software and integration partners. Do the groundwork on the subject matter and challenge partners to find the best solution to fit goals the company has set out to achieve. The eighth step is to test the water. A pilot program must be developed and tested to determine how the system will perform in the environment it will be functioning in. Problems and enhancements can be tested before the system is implemented company-wide. The pilot can determine where the readers will work the most effectively, how the tags respond to the environment and where to place the tags on the packaging material. The ninth step is to prepare for deployment. Companies need to look at retracing various steps to determine if they have addressed all of the requirements setup prior to fully implementing the RFID system. Changes to any business process found in the pilot or other steps have to be completed prior to bringing the system to final implementation. This is the chance to examine the system and fully understand the impact it will have on the business. The tenth and final step is to join the cause. Joining and participating in an organization such as EPCglobal will help the company gain

knowledge and understanding in addressing an implementation plan for RFID. Experience is a key to any major system installation and the more a company can gain by using other resources the better off they will be in the long run.

CHAPTER III: METHODOLOGY

Introduction

The objective of this section is to describe how the researcher conducted the investigation into the desired information about RFID systems, the Wal-Mart proposal and an implementation method for SMG Manufacturing. The researcher developed and made use of the historical methodology in forming opinions and conclusions about RFID. Researching prior documents and articles produced by authors from the EPCglobal network, formally the Auto-ID center, which is the leading research facility on the RFID technology, helped the researcher find the information needed for this research project. Since Wal-Mart announced the proposal to utilize RFID technology, companies such as SMG Manufacturing are moving quickly to understand the implications RFID will impose on the company. Using the Internet and other literary works, the researcher has been able to gain the necessary knowledge to take the correct action for this study.

Description of methodology

The purpose of this study is to identify the necessary factors affecting RFID, the Wal-Mart proposal and a RFID implementation. The historical method, utilizes previously produced documents, which gives the researcher the essential knowledge about RFID, Wal-Mart and RFID implementations. Historical analysis begins with a critical review of sources, pointing to evidence around some argument or thesis, developing a course of events to prove or disprove some sort of idea, proposition or

hypothesis (Etten). The researcher used the historical method, striving to draw on documents from the leading experts on RFID in formulating opinions and conclusions. The researcher reviewed documents which leading sources in the RFID field have created pertaining to RFID systems and implementation approaches. Determining the issues, problems and concerns of RFID systems are difficult and to build on information others have developed helps SMG Manufacturing gain an improved understanding of this technology. SMG Manufacturing can better manage the business systems affected by RFID, by establishing a strategy to bring a RFID system to completion successfully.

Research design

The goal of the research design is to create a strategy to make a choice on solving a specific question (Webref). The specific questions in this research project that need to be satisfied are; what is RFID, how does RFID and the Wal-Mart proposal affect SMG Manufacturing, and what is a workable implementation strategy for SMG Manufacturing. Research design assists the researcher find the information essential to move ahead. This helps discover answers to questions and construct conclusions. The researcher used previously authored articles, since the RFID technology is still experimental and there are few literary works out in book form. Using current documents from all available sources justified how the researcher selected to design the research project. Defining RFID was the first step to developing the information needed to help make assessments about the Wal-Mart proposal and the SMG Manufacturing implementation. Wal-Mart generated a guide to help SMG Manufacturing understand the process needed to fulfill their

requirements. Zebra technologies created a step by step implementation strategy, which SMG Manufacturing can take advantage of when developing their implementation plan.

Procedures

The procedure the researcher employed was to develop an outline of RFID, the Wal-Mart RFID proposal and RFID implementation methods. Inquiring into technology changes was the first matter the researcher undertook. The researcher investigated the effect RFID will have on the supply chain such as, giving a business insight into inventory control, asset management, out of stocks and uncovering cost savings throughout the supply chain. The next matter was to consider how technology altered the approach companies are able to build on with the RFID technology. Advances in wireless, databases and Internet knowledge have brought improvements to companies so they can collaborate and change the methods of accomplishing new business practices. The researcher explored bar codes and the influence on business procedures the bar codes developed. The bar code changed the structure of business back in the 1970s and has become a major improvement to this day on the interaction between businesses. The researcher next explained the structure of the RFID system. Researching RFID begins with the Auto-ID center, which is the principal source for making RFID become a technology gaining value to companies such as Wal-Mart, Target, Department of Defense, and others. The researcher with the help of the Auto-ID center identified the different components of the RFID system such as, Electronic Product Code (EPC), Savant, Object Name Service (ONS) server, Physical Markup Language (PML) server, tags and readers. The different components work together to create the RFID system.

Current uses of RFID helped the researcher expand on how technology is being employed by different industries helping them deal with problems they may face producing and tracking products. Discovering how to implement this technology is one of the major goals in this project. Determining the best action plan for implementing the RFID technology took the researcher through many articles and documents trying to uncover the best fit for SMG Manufacturing and the approach, which gives them the optimum match. The researcher also studied Wal-Mart and the effects their proposal will have on SMG Manufacturing. Wal-Mart is the first major retailer to require Consumer Packaged Goods (CPG) manufacturers develop RFID systems. The burden is on the manufacturers to have a working RFID system in place by 2005 and 2006. The researcher obtained and investigated the Wal-Mart requirements using information on Wal-Marts retail-link, an integrated inventory and replenishment system and other documentation produced by RFID equipment and service providers working with companies developing RFID systems.

CHAPTER IV: RESULTS

Introduction to SMG International, Inc

SMG International manufactures and converts containerboard, boxboard, coated and uncoated fine paper, and tissue paper. The company employs approximately 14,000 employees, with more than 150 facilities located in the United States, Canada, France, Sweden, Germany, England and Mexico. The company recycles more than two million tons of paper and board every year. SMG International is comprised of six industrial groups, thirteen sectors of activities and the corporate administrative departments. The company generates over 3.4 billion in sales. SMG International's vision is as follows: The keys to success in tomorrow's world are versatility, productivity, and profitability. Companies having a decentralized structure with minimal hierarchy, where employees operate in a human environment, as part of independent and responsible teams, can achieve those aspects. In such a company, the employees, share an overall vision of the corporation, its mission, and the needs of its customers, and participate directly in its development, its strategy and its profits. SMG International has firmly established those qualities and that vision, inspired by the philosophy and values it has cultivated among its ranks since its foundation. SMG Internationals ongoing commitment to those values provides our best guarantee for the future (SMG International Annual Report 2003). SMG Manufacturing, Inc. is part of this total independent and responsible team and is one of the six sectors of SMG International. It is also the main business sector this research project has been developed for.

SMG Manufacturing, Inc.

SMG Manufacturing, Inc. with seven mills located in Canada and nine mills in the United States offers customers a sizable assortment of quality and value paper products, serving a customer base that spans across North America. This sector has more than doubled in the last three years, increasing sales revenue from $320 million in 2000 to $682 million in 2002. The finished product area includes two markets, retail and commercial/industrial. This business sector controls approximately 20% of SMG International net sales and produces 125,000 short tons annually of paper. The retail division, in addition to producing its own brands, is a major supplier of store-brand products for major retail, grocery and drugstore chains. It has developed innovative production lines of bathroom tissue, paper towels, paper hand towels, facial tissue, paper napkins and other related products. The retail division contains business groups in Canada and the United States (SMG International Annual Report 2003). The U.S. group is the primary subject of this research paper, because of initiatives from major U.S. retail and grocery chains such as Wal-Mart, Target, Albertson and others. These initiatives will force SMG Manufacturing's U.S. division to take the lead on developing a RFID system. This division started to invest and develop systems that will be essential in order to install any RFID system. Wireless technologies are setup and new systems are being tested in all production facilities and warehouses. The experience this business division is gaining will be invaluable when it begins testing readers and tags in a RFID system. The division is part of UCCnet, which is an integral element of any RFID system. UCCnet is a nonprofit division of the Uniform Code Council (UCC). UCCnet is a database where manufacturers enter item information in a single database so retailer and grocers can

obtain this information and enter it into their computer systems. This allows each company to have the same information, saving time and money chasing down item mistakes. These two systems are components to the RFID system and because SMG Manufacturing is developing UCCnet and wireless technology systems they will be ahead of the curve when they are required to install a RFID system to connect with other retailers and grocers.

RFID Systems Affecting SMG Manufacturing

The Wal-Mart proposal includes the top 100 suppliers tagging pallets and cases at the warehouse and Direct Store Delivery (DSD) formats by January 2005. By the end of 2006 products from all suppliers in every U.S. region will be using RFID with Wal-Mart. Wal-Mart specifically expressed to all vendors that they would not accept price increases due to RFID. This makes it difficult for manufacturers to justify using RFID; the manufacturers will need to find supplementary methods, which create other RFID opportunities. SMG Manufacturing must have a working RFID system for Wal-Mart by the end of 2006 (Wal-Mart Supplier Briefing 2003). Although SMG Manufacturing retail division consists of six manufacturing facilities and eight warehouses, they currently supply Wal-Mart through three manufacturing facilities and three warehouses. Two of the manufacturing facilities have outside warehouses that will need to be addressed, but because of initial costs, these warehouses will not be developed in the preliminary RFID setup. This requires a change to the current way items are stocked in each location. The Wal-Mart items cannot be inventoried in the outside warehouse until such time the warehouses are setup within the RFID system. The RFID system needed for Wal-Mart does not include the Object Name Service (ONS) or the Physical Markup Language

(PML) servers. When Wal-Mart receives product from a manufacturer and reads the tag coming into their warehouses, Wal-Mart will transfer the product information into their systems. Once the information is in the Wal-Mart systems they will use this information internally, but Wal-Mart will not send the Electronic Product Code (EPC) across the Internet back to the manufacturer, using the ONS and PML servers, instead the information will be sent back through the Electronic Data Interchange (EDI) system. This design gives Wal-Mart an excellent opportunity inside their systems to track products through their supply chain. The design does not give any advantage to manufacturers, needing to know the location of their products inside Wal-Mart distribution centers and stores. SMG Manufacturing will create a RFID system which will take advantage of using the Internet and build the system with the ONS and PML servers, so when the time comes for Wal-Mart and others to send the EPC information the infrastructure is in place. UCCnet is another factor in the RFID proposal from Wal-Mart. UCCnet is a database depository within the Uniform Code Council (UCC) which standardizes data flow from supplier to retailer. UCCnet will eliminate re-keying of data, provide more accurate item level data, standardize data elements, speed up item creation, provide an electronic review and approval process and build a foundation for future applications such as RFID. The UCCnet structure is based on the Global Location Number (GLN). SMG Manufacturing uses the warehouse number of where the product will be supplied from as the GLN. The Global Trade Item Number (GTIN), which is similar to the Universal Product Code (UPC), but derived differently, is also attached to the UCCnet structure (UCCnet 2004). The Wal-Mart Supplier Briefing (2003) has an example of the 96-bit EPC tag data structure Wal-Mart will use in the RFID tag. The tag structure includes the

GTIN from UCCnet. Wal-Mart has outlined the requirements needed to install a RFID system to meet their specifications in a twenty-five-page document. The document summarizes the guidelines and requirements needed to comply with the Wal-Mart proposal. The following table 1 illustrates the breakdown of the Wal-Mart 96 bit EPC tag structure requirements from the Wal-Mart guidelines.

Wal-Mart EPC Information					
UPC	0 787452 46165 6				
GTIN	1 0078742 46165 3				
EPC	00 78742 1 46165				
EPC Manager	0078742				
Object Class	146165				
Wal-Mart EPC TAG Structure					
Header/GTIN	Object Type/Case	Partition	EPC Manager/Mfg Number	Object Class/Item Number	Serial Number/EPC Number
10078742461653	011	101	0078742	146165	1234567891
16 bits	3 bits	3 bits	17 bits	27 bits	38 bits

Table 1: Wal-Mart EPC Tag Information and Structure

SMG Manufacturing needs to understand these guidelines and use them to develop and direct the approach to implementing a RFID system, keeping in mind this is only the Wal-Mart guideline. The Wal-Mart system will be the first outside RFID installation, but not the last, so any system developed must be built with future applications in mind. SMG Manufacturing needs to develop a RFID system, which helps them gain a better Return on Investment (ROI) and reduces costs throughout the supply chain.

Costs Associated with a RFID System

Jonathon Collins (2003) states, AMR, an independent research analyst firm, research estimates that a typical consumer goods company shipping 50 million cases per year will spend $13 million to $23 million to deploy RFID to meet Wal-Marts requirements. Red Prairie (2003) goes on to add this cost is particularly alarming because there is no payback from this investment – it only buys compliance. A.T. Kearney (2003) estimates the cost of EPC and RFID adoption to retailers is estimated at $400,000 per distribution center and $100,000 per store, with an additional $35 to $40 million needed for system integration across the entire organization and the retailer does not have to apply or purchase the tags. These costs are staggering and show this technology is a major investment and cannot be engaged without due consideration from an implementation perspective. Planning will be a major phase to avoiding unnecessary costs. SMG Manufacturing is not alone in incurring RFID costs and has the added advantage of other companies dealing with developing new systems that will work with all customers wanting to use RFID before they have to develop their own system.

SMG Manufacturing when deciding on RFID costs will need to group the costs incurred into several categories, as it does with any other major Information Technology (IT) project. The first category will be tag costs. Tag costs currently range from 25¢ to 30¢ per tag (Collins 2004). Wal-Mart is shipped approximately three million cases of product per year. With three million cases being shipped at 25¢ to 30¢ per tag, tag costs for Wal-Mart alone will range from $750,000 to $900,000 per year. If tag costs were to drop to 15¢ per tag by the time SMG Manufacturing installs the RFID system, they will save half of the tag costs. Tags incur additional labor costs if attached to cases and pallets manually. The second category of costs will be readers. Readers generally are priced at approximately $1,000 per reader depending on the functionality that needs to be performed by the reader (Auto-ID Center). The readers SMG Manufacturing needs to purchase and install will cost about $1000. Three facilities will be involved in tagging cases and pallets for Wal-Mart. One facility has three dock doors for Wal-Mart products and two other facilities each have fifteen doors. The cost of the readers for the three facilities will add another $33,000. SMG Manufacturing can lower this cost if it develops the initial phase through only a limited number of dock doors at each location. This will add complexity to the shipping facility personnel. As more readers are added throughout these facilities and others, reader costs will increase. Reader costs will decrease as additional companies start using RFID and technology advances make them more affordable, similar to the tags. Readers will incur additional costs for labor involved in installation and support, network support and cabling, and general support fees, which are, required elements of the overall reader costs. Another category is hardware and application costs. These costs will be the hardest to determine and also have the potential

to be the most expensive. Hardware costs will include both ONS and PML servers needed to bring the EPC data together. If the company can use current hardware, this can significantly reduce initial costs. The hardware costs need to be evaluated by the appropriate IT personnel. Application costs include categories for software, labor, training and startup costs. Software costs take into account middleware; middleware according to Webopedia is software that connects two otherwise separate applications, licenses and maintenance and support fees. Labor costs consist of project management, application development and integration, network support and warehouse staff. Other costs associated with the application, will be training the required staff and any expenses related to the startup of the application. An additional category of cost related to a RFID implementation is subscription fees. A company the size of SMG Manufacturing will be charged a $25,000 subscription fee annually for participating in EPCglobal (EPCglobal, 2003). According to the EPCglobal organization, EPCglobal is industry's trusted partner for driving the global adoption and implementation of the EPCglobal Network across industry sectors. EPCglobal's mission is to make organizations more effective by enabling true visibility of information about items in the supply chain. To that end, EPCglobal develops and oversees standards for the Electronic Product Code (EPC) network. Additionally, EPCglobal provides a global EPC number registry service for electronic product codes in the supply chain (EPCglobal, 2003). Another cost will be for antenna and multiplexers. According to the Auto-ID center (Chappell, Ginsburg, Schmidt, Smith, Toboloski, 2002) the antenna is a subsystem of the reader. There is a different antenna for each different application such as shelf, mat portal, wand or directional antennas. Each antenna costs in the range of $25 to $500 depending on the

base operating frequency. Multiplexers allow many antennas to be physically connected to a reader. Multiplexers range from $500 to $2,000 depending on the number of ports and also may require additional communication cards, which cost approximately $250. An additional cost in a RFID installation would be controller costs. Controllers are simple computers that run software, which control the reader. The controller costs are $1,000 to $3,000. Consulting fees add extra cost for RFID. There are many consulting companies out there claiming to know RFID and advertise they are able to be compliant with Wal-Mart. SMG Manufacturing needs to do its homework and determine which consultants have been successful with other companies when installing a RFID system for Wal-Mart. The consulting firm should also be involved in other applications needed to help consumer manufacturing goods companies such as SMG Manufacturing gain a better Return on Investment (ROI). Bringing the RFID implementation to a successful conclusion will be the top priority for SMG Manufacturing and they will need to find a consulting firm that has the same vision. Having other companies pioneer this technology will give SMG Manufacturing a chance to find consultants familiar with the Wal-Mart proposal and help them verify the consulting firm that can install the system beyond just the Wal-Mart RFID proposal. There may be other costs associated with this project, which are yet to be determined and established, because this technology is in the infancy stage. As the implementation proceeds, controlling these costs will be a major factor in bringing the RFID project to a conclusion on time and within budget. The initial expenditures, including tags, readers, subscription fees, antennas, multiplexers, communication cards and controllers will be approximately $1.2 million dollars.

Additional costs of RFID printers, consultants, middleware and labor can push the price tag into the $2.5 million range for SMG Manufacturing.

RFID Benefits

RFID systems are expensive to install, but they also have the potential to gain a remarkable amount of benefits if strategically applied across the supply chain. The benefits added will have a direct impact on the bottom line for any company implementing RFID. The primary areas will be (Chappell, Durdan, Gilbert, et al 2003):

1. Reduced Safety Stock Inventory – The need for safety-stock inventory will decline due to the reduced lead-time and reduced lead-time variability on both inbound and outbound segments of the supply chain.
2. Labor Reduction – Labor costs will decline in the distribution segment through the automation of processes and the removal of many of the verification and auditing steps.
3. Shrink – Shrink will be reduced by decreased receiving and paperwork errors during both the distribution center receiving process and the vendor loading process.
4. Visibility to All Assets – Whether company owned, leased or provided by a third party, the associated assets and their utilization rates will increase. This also increases the visibility to products as they move through the inbound and outbound segments.

Wright (2004) adds yard operations will benefit because they will be able to locate trailers when needed by placing temporary tags on the trailers in the distribution process

while trailers are waiting to be loaded. Pallet, case put-away and picking are an advantage by being able to locate the items while experiencing no inventory loss. A company can eliminate, the where is the inventory problem. This is where RFID will get the quickest payoff for manufacturers in the Wal-Mart proposal. Staging of the product improves, because the system knows where the customer's order is in the system and that it has been filled correctly. RFID will also track assets. Forklifts, bins, pallets, dollies and other assets can be tracked throughout a manufacturing plant. Preventive maintenance also benefits from RFID tags. Kimberly Clark (KC) has started a project to place tags on a paper machines mechanical components, whenever a component is replaced as a function of their preventive maintenance schedule. The tag contains the part number being replaced. KC uses a handheld reader to scan the tag as an employee walks down the paper machine with the reader; the reader scans the tags and sends the part number back to the maintenance parts scheduling software. The scheduling software informs maintenance if any part needs to be replaced immediately (O'Shea, 2003). Other benefits achieved with RFID collecting detailed, accurate and timely information will be increasing the overall equipment efficiencies. When operating efficiencies increase, a company can enhance capacity utilization and yield, reduce lead-times, improve product quality and increase labor productivity (Chappell, Ginsburg, Schmidt, Smith, Toboloski, 2002). Impacts on the company's manufacturing operations by tagging items will include reducing product obsolesce, tracking and managing spare parts inventory, facilitating statistical process control, reduce returns and warranty claims, and reduce scrap, waste and obsolesce. SMG Manufacturing needs to take advantage of the above-mentioned benefits as soon as possible. Gaining these improvements will help deliver a quicker ROI,

because of the efficiencies gained in manufacturing and as stated by Alexander, Birkhofer, Grambling, et al (2002), benefits increase significantly as companies transition from pallet, to case, to item-level tagging.

Top Management Involvement

To become a successful project for SMG Manufacturing, the RFID project must obtain top management involvement. Top management for SMG Manufacturing will entail the management committees' of SMG International, which include the Chairman of the Board, Chief Executive Officer (CEO), Chief Financial Officer (CFO), Chief Information Officer (CIO) and the presidents of the six sectors associated with SMG International. This group will have the overall decision-making power to fund the RFID system in each sector of the business. The management team of SMG Manufacturing is the group intimately involved in the RFID research project. This team consists of the President of the division, the Vice Presidents from operations, sales, accounting, marketing, and information technology. This team will be the driving force behind the leadership needed to implement this project. According to Prosci (2002) in a benchmarking report on the role of executive leadership in the business process reengineering, the top management team should contribute the following:

1. Demonstrate commitment and support for the project.
    a. Be a visible and active sponsor; participate in key project activities.
    b. Review project status frequently and monitor progress.
    c. Enforce the reason for change continually throughout the organization; communicate expected outcome.

    d. Ensure speedy reviews at key decision points in the process.
    e. Let managers and employees know what will be expected from them during this process.
2. Provide the needed resources to the team.
    a. Assign staff full-time where possible.
    b. Provide the required space and equipment for the team.
3. Set the stage for reengineering by determining core business processes and by defining the project scope and objectives.
4. Provide adequate funding.
    a. Enable the team to attend reengineering and change management training.
    b. Allow for travel for benchmarking and research.
    c. Contract with external experts and consultants when necessary.
5. Be a risk taker by challenging existing assumptions and processes. Set new standards and encourage others to be open to innovative approaches.

Because RFID will be a critical and expensive project, executive sponsorship plays a crucial role in determining whether the project is successful. The management team within SMG Manufacturing has a vast amount of experience with technology changes and this application will not differ that much. The major source of concern for RFID will be dealing with the payback portion. This project will not create a favorable ROI in the short term, but will continue to build as the groundwork and processes are put in place. Funding is a key concern and management must understand how RFID will develop into a key technology. Changes will take place fast and SMG Manufacturing has to take advantage of the technologies that present themselves, in order for the company to gain a

competitive and economical resolution to problems brought upon the company as a result of its competition and customers.

Future RFID Applications

The final step in the RFID system implementation will come from item level tagging and developing smart shelves at the retail level. Smart Shelves will increase the item level information that CPG companies have been yearning to find out for years. Systems such as Vendor Managed Inventory (VMI) and Wal-Marts retail-link, an integrated inventory and replenishment system, have given companies diluted Point of Sale (POS) information, but they have not developed into the systems needed by manufacturing to understand information at the item/consumer levels. With smart shelves a company can gain this information rapidly and began to understand consumers buying habits. The information will be able to give the consumer a better shopping experience by having stock on the shelf, when the consumer wishes to purchase it. Out-of-stocks will become nearly non-existent and product deficiency can be handled quicker and with a better response, since the manufacturing company can respond to the problems within their organization immediately.

Metro of Germany, the world's fifth largest retailing company, has created a concept entitled the ‘future store’. The future store was built to demonstrate how the new RFID technology can bring a more favorable shopping experience to the consumer. According to Thomas (2003) the store showcases the RFID tagging of goods and services. Projects included; personal shopping assistants, electronic shelf labeling, intelligent scales, self-checkout stations or RFID checkout through readers, and

couponing systems. The purpose of the future store is to demonstrate to manufacturers and retailer the benefits added when both sides cooperate and implement technologies similar to RFID.

Other systems will be developed once manufacturers and retailers gain a better understanding of the potentials of RFID systems. Other industries will also gain more knowledge from CPG manufacturers and will be able to begin using this technology. As the researcher mentioned previously in the RFID current uses section this technology is beginning to take shape in other industries such as skiing and books. RFID has become what bar codes were back in the 1970s. The future of this technology is fast becoming a reality. As with bar codes systems which have progressed over the years, RFID systems are on the same pace. Anthony Bigornia (2004) stated, this technology is going to happen. I thought it would die, due to the expense of the system, but it has gained so much momentum that it will be hard to stop.

CHAPTER V: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

Back in the 1970s the bar code made an impact in the way companies communicated and collaborated amongst themselves. Radio Frequency Identification (RFID) currently is at the same phase as the bar code was in the late 1960s to the early 1970s. With the advancement of the computer, Internet, wireless, databases and other tools, the development of new ways to trade information has assisted companies gain enhanced methods in which they evaluate items at each stage of the supply chain. Manufacturers and retailers are not certain RFID will change and advance current business processes. Most companies perceive RFID as a positive step to gaining additional information about their items, which has been missing in the supply chain for a while, but companies are also skeptical about all of the benefits this technology has touted.

The previous four chapters in this research project have presented a detailed representation of RFID, the Wal-Mart RFID proposal and an implementation method suited for SMG manufacturing. Chapter One introduced the research and determined the intention, questions, boundaries and terms used throughout the research paper. Chapter Two contained an extensive literary review of RFID, bar codes, supply chain, technological advances and current uses of RFID systems. Chapter Three described the methodology, design procedures and limitations of the research project. Chapter Four defined the organization costs, benefits and top management involvement in the RFID

system. Chapter Five contains a brief summation of the previous four chapters, the conclusions and recommendations for SMG Manufacturing.

Summary of Findings

The primary purpose of this study was to give assistance to SMG Manufacturing in determining the requirements of RFID.

The supply chain is affected by RFID in several ways. Inventory, stock outs, transportation and other functions are involved in the supply chain and RFID will affect each of them in a different manner. Supply chain initiatives help companies construct better ways of eliminating costs. RFID is another technology to help remove costs from the supply chain. Technological changes have made RFID available to be considered a viable option to compliment bar codes. RFID would still be regulated to being just another idea without advances in wireless, Internet, and database expertise. Wireless technology is part of the mainstream business processes. Companies are setting up wireless system in offices and manufacturing plants to help them deal with an ever-changing business environment. The Internet is another technological change, which has changed every ones life, and this is especially true for businesses. Using the Internet is part of many activities and is developing into a tool companies cannot manage their business without. Being able to send data via the Internet has developed as one of the strengths of any RFID system. The Internet will produce information between business partners quicker and more reliably. Databases, another technological change, are more efficient and effective in handling volumes of data, which pass through them. RFID will add more complexity to databases with case and item level tagging, so they need to be

developed to manage tremendous quantities of information. Bar codes will not diminish because of RFID. The bar code is a robust and reliable system. The bar codes and RFID will need to work in conjunction with each other until the time comes where the RFID systems are robust and reliable enough to eliminate the need for the bar code. Reading and analyzing RFID systems provided the greatest challenge undertaken by the researcher. Developing an understanding of RFID is a time consuming and sometimes frustrating accomplishment, because of the number of articles written on the subject. Filtering the articles and determining what is required in a RFID system, helped the researcher discover the correct segments essential to RFID. RFID is separated into five segments:

1. The Electronic Product Code (EPC)
2. Object Name Service (ONS)
3. Savant, Physical Markup Language (PML)
4. Readers
5. Tags.

The EPC is the catalyst of the RFID system. It consists of four fields, the header, manufacturer number, product number, and a unique serial number. A RFID printer affixes the EPC to the RFID tag and this is the information scanned by the RFID reader. The ONS is a computer server, which stores the EPC tag information. The ONS works the same way as the Domain Name System (DNS) on the Internet, by pointing a request for a particular EPC to the location on the ONS server. ONS servers should be located locally for quicker retrieval. The Savant is a data router, which filters EPC tag information between RFID readers and a company's enterprise network system. The

filtering system is needed because a RFID reader may detect hundreds of EPCs per second. The PML server describes the object (case, pallet, bag, razor pack, etc.), translates object information (dosage, temperature, location, etc.) and provides snapshots of the EPC data as it travels through the supply chain. The RFID tag is divided into two categories, passive and active. Active tags are used for longer distance reads (10 feet and beyond) and are controlled by a battery in the tag. The passive tag is the tag being used by Consumer Package Goods (CPG) companies working with retailers and grocers on RFID systems. The passive tags do not contain a battery, but draws power from the reader. The passive tags are less expensive and are smaller, fit on a bag of chips instead of a railroad storage car. The RFID reader uses a magnetic field to communicate with the tag. RFID readers need to avoid reader collision, when one reader interferes with another reader, by utilizing a Time Division Multiple Access (TDMA) scheme. TDMA ensures readers do not overlap. TDMA is a standard, which reads the first digit of the EPC, and if more than one EPC responds with a match, the reader asks for a response using the first and second digits and keeps trying this scenario until a single tag responds. RFID readers for passive tags read fifty tags in less than a second and have read ranges of four feet or less. Companies such as Ford, Gillette, and Johnson Controls have publicized the RFID technology and proven the technology can be used in different settings and provide a viable solution to a business problem. Implementing methods developed two common themes associated in each implementation plan. First develop a pilot test. Problems and enhancements can be tested during the pilot to improve the system before a company-wide implementation. Second, get the top management of the company involved. Top management has to contribute to the overall success of the project. They need to be

visible, review the project status, reinforcing change, provide the necessary resources and funding, set the stage for business process changes and lastly be a risk taker. Key to providing the required talent, equipment and funding to ensure the RFID project is brought to a successful conclusion on time and within budget is top management.

RFID systems are becoming a necessary technology that companies need to embrace in order to gain an advantage and in some cases stay equal to their competition. A lot of hype and negative press is being written about RFID, but digging deeper into the system, companies will determine this technology, when implemented properly will result in vital benefits internally and externally. Discovering the benefits is time consuming and expensive, but gaining the benefits and advantages over the competition gives companies the incentive to pursue technologies such as RFID.

Conclusions

Companies are discovering details about RFID and attempting to understand the impact the technology will have on the supply chain. Based on the review and inquiry from chapter two and chapter four the researcher developed five separate conclusions.

The Wal-Mart proposal will affect SMG Manufacturing starting in 2005 and concluding in mid to late 2006. Wal-Mart is determined to build a RFID system. They are setting up warehouses with readers, testing different tags and developing an internal infrastructure to handle the RFID information generated using EPC information. Wal-Mart is setting the standard for all other retailers and grocers to challenge or follow. They have moved forward with the RFID technology to gain an advantage over the competition. Wal-Mart has always set the bar higher, because they want to push vendors

to find ways to take costs out of the supply chain and pass them on to the consumer. RFID is another technology Wal-Mart feels will bring savings to all involved. RFID is being utilized to provide the consumer with an improved shopping experience. RFID and Wal-Mart cause problems for CPG manufacturers, because they will be bearing the burden of the expense to install and test the RFID system. The current Wal-Mart plan proposes a RFID system (tagging pallets and cases) in place for the top 100 suppliers by the end of 2005 and for the rest of the suppliers by the end of 2006. SMG Manufacturing being a private label manufacturer will gain a slight advantage over branded manufacturers in the Wal-Mart plan. Branded manufacturers will incur an additional labor cost to break down pallets being shipped to Wal-Mart due to the fact they do not specify individual cases and pallets for Wal-Mart. These manufacturers will have to tear down the shrink-wrap on the pallet, tag the cases, shrink-wrap the pallet again, tag the pallet, and then send the pallet to Wal-Mart. This scenario is the cheapest alternative, because of the expense involved with tagging every case and pallet. Wal-Mart has specified they will not take a price increase due to RFID. This is a difficult stipulation for manufacturers, so they need to look at other applications for further benefits to offset these additional expenses.

SMG Manufacturing must develop an implementation method similar to the one discussed in chapter two by Zebra Technology. Planning the RFID implementation properly can take out inefficiencies and expenses giving SMG Manufacturing confidence to build the system, which improves business processes. SMG Manufacturing needs to efficiently capture, store and apply the information generated by the RFID system. Focusing on key questions, RFID will offer SMG Manufacturing the system crucial to

accomplishing the goal of resolving the Wal-Mart proposal and improving internal business processes. Piloting is a necessary step to deploying the system accurately, making sure all essential steps are tested and analyzed before employing RFID company-wide.

Spending will be a major point of contention. Up-front RFID costs will result in a vulnerable Return on Investment (ROI). Controlling RFID expenditures and expenses will be a primary focus of the RFID team SMG Manufacturing selects to implement the system. Determining the best cost to performance balance, helps the company establish a budget that is achievable and can be accomplished in the least amount of time.

Top management must be involved in the RFID development. Without the guidance and assistance of top management the RFID system will not attain a competitive and economical solution to the challenges RFID brings to SMG Manufacturing. Executive sponsorship creates the environment required to bring together personnel, financing and support to ensure the RFID project gets completed and meets the requirements both internally and externally of the RFID implementation.

Benefits gained from other applications other than the Wal-Mart proposal, such as asset visibility, internal inventory control, labor reduction and maintenance parts tracking system will develop a more robust and reliable system. Adding these functions can level out the expenses incurred in the up-front costs of implementing the RFID system and obtain a better payback because SMG Manufacturing realizes the benefits internally. Inventory control with RFID can reduce idle inventory through the effective use of the information provided by the RFID system (Active Wave, 2001). Maintenance parts selection and tracking using RFID increases overall equipment efficiencies by collecting

detailed, accurate and timely information. Labor expenses decline through the automation of procedures and the elimination of verification and auditing steps. Asset visibility increases by identifying and knowing the location of items and equipment throughout the manufacturing site.

Recommendations

The researcher would propose four recommendations to SMG Manufacturing on developing, implementing and understanding RFID.

The first recommendation is to get involved in the RFID movement. Join EPCglobal, the Electronic Product Code (EPC) network and increase the company's knowledge and perception of RFID. EPCglobal is the leading industry standard for RFID and the earlier SMG Manufacturing gets connected to the resources this network supplies, the easier the system will be to manage and install.

The second recommendation has initially been presented, by allowing the researcher to conduct this study on RFID. Understanding the inner workings of a RFID system, the Wal-Mart proposal and a RFID implementation plan is a huge step towards applying the research information provided into developing a practical and useful RFID system. Utilizing the analysis and conclusions the research project developed, SMG Manufacturing can begin to recognize and validate the need to pursue the RFID technology.

The third recommendation is to keep up-to-date on RFID information. Seminars and conferences are being conducted frequently on the subject of RFID. They provide the most current information on RFID systems developed by manufacturers, retailers,

grocers, consultants and equipment suppliers. Attending the seminars will be a major move to getting the information needed to develop RFID internally. SMG manufacturing needs to browse the Internet for current articles and commentary on issues involving RFID. They have to stay ahead of the next business employing this technology.

The fourth and final recommendation is to get started. Wal-Mart and other retailers are not going to stop pursuing this technology, even with the bad publicity being generated in the press. SMG Manufacturing can get ahead of the competition by developing RFID immediately. Obtain executive sponsorship and construct an implementation, business process change and development plan as soon possible to put together funding for the RFID project and get it on track.

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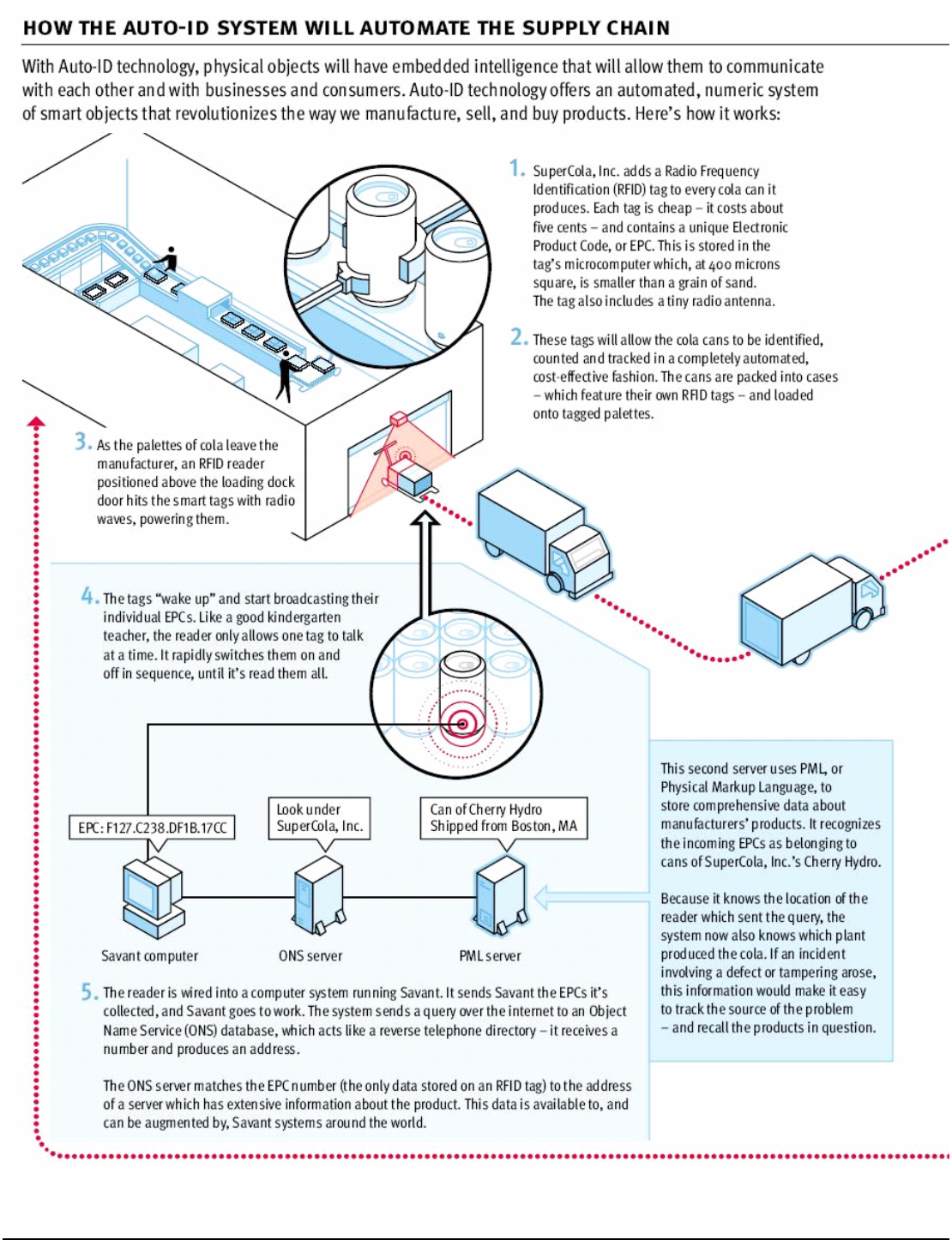
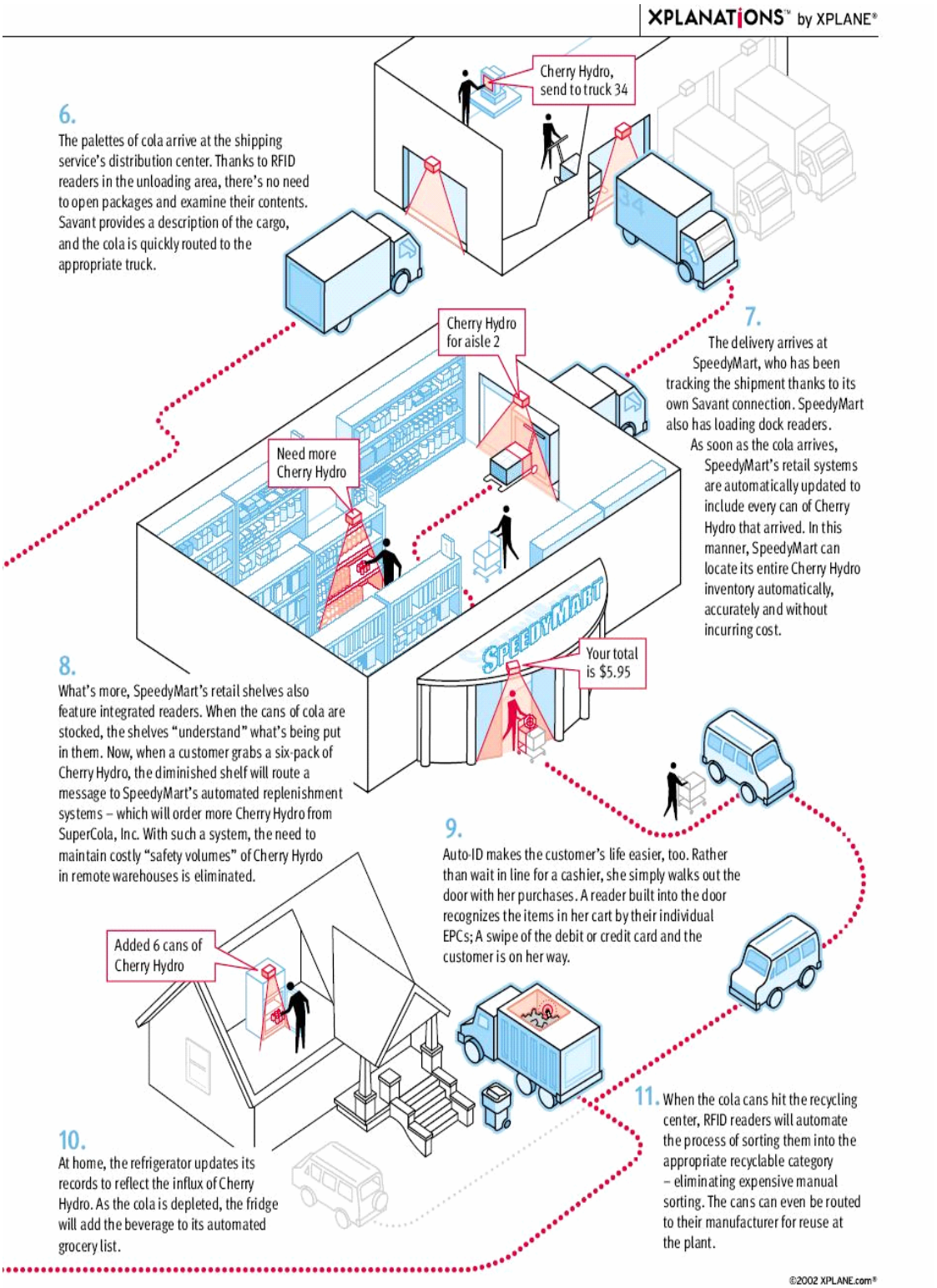
Appendix A

The following is an illustration from the Auto-ID Center Technology Guide (2001).




XPLANATIONS™ by XPLANE®
Cherry Hydro, send to truck 34
6.
The palettes of cola arrive at the shipping service's distribution center. Thanks to RFID readers in the unloading area, there's no need to open packages and examine their contents. Savant provides a description of the cargo, and the cola is quickly routed to the appropriate truck.
Cherry Hydro for aisle 2
Need more Cherry Hydro
7.
The delivery arrives at SpeedyMart, who has been tracking the shipment thanks to its own Savant connection. SpeedyMart also has loading dock readers.
As soon as the cola arrives, SpeedyMart's retail systems are automatically updated to include every can of Cherry Hydro that arrived. In this manner, SpeedyMart can locate its entire Cherry Hydro inventory automatically, accurately and without incurring cost.
SPEEDYMART
Your total is $5.95
8.
What's more, SpeedyMart's retail shelves also feature integrated readers. When the cans of cola are stocked, the shelves "understand" what's being put in them. Now, when a customer grabs a six-pack of Cherry Hydro, the diminished shelf will route a message to SpeedyMart's automated replenishment systems – which will order more Cherry Hydro from SuperCola, Inc. With such a system, the need to maintain costly "safety volumes" of Cherry Hyrdo in remote warehouses is eliminated.
9.
Auto-ID makes the customer's life easier, too. Rather than wait in line for a cashier, she simply walks out the door with her purchases. A reader built into the door recognizes the items in her cart by their individual EPCs; A swipe of the debit or credit card and the customer is on her way.
Added 6 cans of Cherry Hydro
10.
At home, the refrigerator updates its records to reflect the influx of Cherry Hydro. As the cola is depleted, the fridge will add the beverage to its automated grocery list.
11.
When the cola cans hit the recycling center, RFID readers will automate the process of sorting them into the appropriate recyclable category – eliminating expensive manual sorting. The cans can even be routed to their manufacturer for reuse at the plant.
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